March 1, 1966

QUARTERLY PROGRESS REPORT

OCTOBER NOVEMBER DECEMBER

1965

Bellcomm, Inc.

[redacted]

Report No. 66-101-1
Contract NASw-417
March 1, 1966

BELLCOMM, INC.

QUARTERLY PROGRESS REPORT

October November December

1965

J. A. Hornbeck
President

BELLCOMM, INC.

Washington, D. C.

QUARTERLY PROGRESS REPORT

DISTRIBUTION

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ABSTRACT

The activities of Bellcomm, Inc., during the quarter ending December 31, 1965 are summarized. Reference is made to reports and memoranda issued during this period covering particular technical studies.

Report No. 66-101-1
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BELLCOMM, INC.

QUARTERLY PROGRESS REPORT

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APOLLO SYSTEMS ENGINEERING STUDIES

MISSION PLANNING

Apollo Flight Mission Assignments

A new draft of "Apollo Flight Mission Assignments" was delivered to the Apollo Program Director.

Payload capabilities of certain launch vehicles in the Saturn IB series were compared with current payload requirements. Recommendations were made for the use of available performance margins on vehicles AS-205 and AS-206.

A preliminary feasibility study of an earth orbital rendezvous using two Saturn IB/Apollo space vehicles was completed. (1)

Constraints on the first Apollo lunar landing mission were collected and evaluated. A preliminary memorandum was published. (2)

Vehicle Performance

Current weight and performance data are being compiled and analyzed for launch vehicles and spacecraft in the Saturn IB and Saturn V series. Significant items were presented at Apollo Program Office reviews during the past quarter.

Guidance Analysis

Guidance and navigation error analysis for the complete lunar landing mission is continuing. Significant changes in the implementation of error propagation are being incorporated as a result of the review of numerical results provided by TRW Systems.

Computer simulations of the entry guidance equations have been prepared to assist MSC in validation activities. (3)(4)

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(1) Analysis of a Proposed EOR Mission Using Saturn IB/Apollo Vehicles, Memorandum for File, L. P. Gieseler (CEIR), December 28, 1965.

(2) Apollo Lunar Landing Mission: Preliminary Considerations for February 1968, Memorandum for File, V. S. Mummert, November 26, 1965

(3) Letter, W. G. Heffron to A. Cohen (MSC), regarding AS-202 guidance equations in MIT Document R-477, October 5, 1965.

(4) Letter, W. G. Heffron to G. Hunt (MSC), regarding Internal Note 65-FM-109 on guidance error analysis, October 11, 1965.

Trajectory Analysis

The study of lunar landing accessibility without the free return restriction on the translunar trajectory was completed during the quarter.[5]

A study of LEM descent trajectories was begun with the objective of providing better visibility for the astronauts as they approach the lunar surface and to review the trajectory shaping in the light of new LEM engine characteristics.

As part of the continuing study of LEM constraints a comparison of LEM ascent to rendezvous profiles was made. In particular the Direct Flight Plan and the Concentric Flight Plan were quantitatively compared for duration of launch window, ΔV requirements, availability of tracking information and terminal rendezvous maneuvers.[6] It was concluded that the Concentric Plan would be the better one.

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(5) A Study of the Behavior of Lunar Accessibility Over Extended Time Periods, Part II - Non-free Return Trajectories, TR-65-310-1. J. S. Dudek, W. D. Kinney, K. Smith, October 22, 1965.

(6) A Comparison of Concentric and Direct Rendezvous Modes for Lunar Orbit Rendezvous, Memorandum for File, D. R. Anselmo, December 17, 1965.

REQUIREMENTS

Apollo Program Specification

During the quarter, draft appendices to the Apollo Program Specification for Apollo Saturn Missions AS-206, 207, 503, 504, and 505 were delivered to the Apollo Program Office Configuration Control Board. These appendices were approved by the CCB.

Comments on the Apollo Program Specification by MSFC were reviewed. As a result of this review and continued work on MSC comments, 75 specification change notices were prepared and submitted to the Configuration Control Board for approval. Work is continuing on the remainder of the MSC and MSFC requests for changes to the Specification.

Apollo Mission Sequence Plan

The Apollo Mission Sequence Plan has been completed and distributed.[7] This document provides an operational statement of the lunar landing mission on which the system design is based and against which the system design can be tested for completeness. It also provides a framework for the identification of open requirements. Work is continuing to refine the mission sequence with particular emphasis on LEM operations.

Mission Rules

Work was continued on the definition of mission rules. Mission rules guidelines for AS-201, AS-202, AS-203, and AS-204 were reviewed. Draft material was prepared for inclusion in the AS-202 and AS-204 guidelines. Specific mission rules, both flight and launch were reviewed for AS-201.

Mission Director's Communications

The Mission Director's communications requirements for GT-5, GT-6, and AS-201 are being evaluated to determine if the existing communications procedures and information flow are compatible with the functions the Mission Director performs.

Operation of Ground Communication Network

As a prelude to the analysis of the planned method of operation of the communication links between the Apollo MSFN and the Control Centers, network operational procedures used in GT-6, GT-7, and GT-7/6 were monitored at GSFC, MCC-H, and MCC-K.

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(7) Apollo Mission Sequence Plan, TR-65-214-1, System Analysis Department, September 30, 1965.

MCC-H Communication Processor

An analysis of the operation of the Communication Processor at MCC-H was begun. Operations under the Gemini workload are being examined with separate analyses being made for the input-output transfer, storage, and processing functions. (8)

Unified S-Band Systems Studies

Work on the determination of the performance margins in the Unified S-Band (USB) system used for Apollo communications was continued during the quarter.

The results of a study to determine the effects of signal interruptions on the operation of phase locked loops such as are used in the Apollo USB were provided. (9) Quantities such as the time required for automatic reacquisition and the maximum duration of an interruption which would permit automatic reacquisition were determined as a function of system parameters.

Communications Blackout During Reentry

It was proposed that additional tracking ships be used to monitor the reentry of Mission AS-202 in order to obtain early data on the blackout phenomena for an Apollo CM reentering at above orbital speed. (10) The addition of a single ship would permit an evaluation of the adequacy of existing theories of the communication blackout.

Summary Communications Report

A report was prepared and distributed summarizing the work performed between April 1, 1965, and September 30, 1965, on the formulation of system requirements and the evaluation of communication facilities to be used for Apollo Missions. (11)

Flight Crew Safety During Launch Abort

In response to Panel Review Board interest an evaluation was made of the Launch Escape Vehicle (LEV) performance during escape from launch vehicle explosions. It

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(8) Project Apollo - Communications Processor - Analysis of Processing (P_1) Function, MF5-4332-54, A. E. Peterson, Bell Telephone Laboratories, Inc. November 22, 1965.

(9) Project Apollo - Study of Carrier Interruption Effects on Phase Locked Loop Operation, MF5-4334-18, J. C. Lumsden, Bell Telephone Laboratories, Inc. September 16, 1965.

(10) Deployment of Reentry Ships During Mission AS-202 to Obtain Pertinent Data on RF Communication Blackout, TM-65-2021-8, R. K. Chen, J. P. Maloy, December 17, 1965.

(11) Summary of Work Performed Under Bellcomm/NASA Task 15 Amendment 2 (April 1, 1965 - September 30, 1965), TR-65-320-1, A. G. Weygand, October 29, 1965.

was determined that increasing LEV acceleration profiles to maximum crew tolerance levels would not significantly increase crew safety.

Flight Crew Tasks Modeling

A computer program for flight crew tasks modeling has been developed. This program permits detailed study of time sequences for both required and optional tasks and provides statistical data on the likelihood that specified tasks can be completed during a mission.

CONFIGURATION

Launch Complex

Discussions with MSC and MSFC led to some relaxation in the hold and recycle restraints identified in the series of studies published during the second quarter of 1965. A technical memorandum(12) updating the previous studies was published.

System configurations that would permit use of common hypergolic fuel loading GSE for both the Spacecraft and S-IVB APS were studied. (13)

Requirements for gaseous nitrogen purge systems used in the Launch Complex GSE were reviewed. (14) Suggestions were made toward increasing the effectiveness and efficiency of the system.

Countdown Status Display

A graphic display of countdown status on a real-time versus T-time has been studied as an aid to making decisions during a countdown. (15)

Bellcomm personnel participated in the resolution of the interface problem between CSM and CM access arm. (16)

Space Vehicles

Configuration matrices reflecting present vehicle-to vehicle differences in the Saturn IB and Saturn V hardware were prepared. (17) Brief summaries of the reasons for the differences in configuration were included.

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(12) Revised Apollo/Saturn V Hold Capability and Recycle Requirements, TM-65-2032-4, C. H. Eley III, V. Muller, H. E. Stephens, November 5, 1965.

(13) Trip Report - Meeting on Hypergolic Loading GSE at MSFC, December 1, 1965, Memorandum for File, G. W. Craft, December 9, 1965.

(14) Trip Report - Discussion on the Implementation of Gaseous Nitrogen Purge Requirements, KSC, October 27, 1965, Memorandum for File, L. G. Miller, November 19, 1965.

(15) Countdown Status Display, TM-65-1031-3, P. S. Schaenman, October 28, 1965.

(16) Trip Report - CM Access Arm Working Group Meeting, Downey, California, October 12, 1965, Memorandum for File, P. R. Knaff, L. G. Miller, October 18, 1965.

(17) Differences of Configuration in Successive Saturn IB and Saturn V Vehicles, Memorandum for File, D. M. Duty, S. G. Embrey, G. R. Huson, November 10, 1965.

Review and assessment of the status of Apollo space vehicle subsystems continued with participation in LEM program reviews, the Design Engineering Inspection for SC 011[18], and the Critical Design Review for the Block II CSM.[19]

A review of the status of Lunar Excursion Module subsystems was completed.[20] It was concluded that the descent engine, the environmental control system, the radar systems, and the reaction control system were subject to significant developmental problems.

A status summary covering those problems associated with the LEM landing gear, the descent engine, and ECS-thermal balance was presented at the Apollo Program Office Review on October 4, 1965.

The problems involved in predicting thrust from tank venting were investigated. A report[21] describing the various S-IV/S-IVB stage venting systems and their deployment concluded that the S-IVB configuration should preclude build up of excessive tumbling rates such as were experienced on the SA-9/Pegasus A flight.

A description and evaluation of the Emergency Detection System Auto-Abort Enable circuitry under consideration for Apollo space vehicles was presented to the Apollo Program Office Configuration Control Board.

Study effort related to thermal constraints on mission operations, requirements for Extra-Vehicular Mobility units, problems associated with the RCS propellant quantity gauging system, LEM weight-performance trade-offs and requirements for the partial pressure of oxygen in the spacecraft was continued.

Effort was directed toward preparation of a draft of Program Directive No. 7 covering Design Certification Reviews. This included an examination of the formal program review process and the preparation and coordination of draft directives.

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(18) Trip Report - Design Engineering Inspection for SC 011, Downey, California, August 30 through September 2, 1965, Memorandum for File, T. A. Bottomley, P. R. Knaff, T. J. McEntee, W. Muller, J. J. O'Connor, P. F. Sennewald, October 12, 1965.

(19) CSM Block II Critical Design Review, November 16-19, 1965, at MSC, Phase I, Memorandum for File, T. A. Bottomley, W. R. Devoto, W. G. Heffron, G. R. Huson, J. T. Raleigh, P. F. Sennewald, December 2, 1965.

(20) Review of Lunar Excursion Module Subsystem Problems, Memorandum for File, T. A. Bottomley, T. L. Powers, R. R. Schreib, P. F. Sennewald, November 8, 1965.

(21) Investigation of Problems Involved in Predicting Thrust from Venting, Memorandum for File, D. M. Duty, S. G. Embrey, November 16, 1965.

A study[22] was conducted to determine the effects of fly-in and nozzle crushing on the abort capability of the LEM descent engine and determination of the minimum altitude for engine operation before flow separation occurs, for the present configuration and for a detachable skirt design at area ratio $\epsilon = 28$. Preliminary indications are that for the present configuration, nozzle crushing may result in thrust vector deflections of up to 20 degrees for non-systemmetrical radial deflection conditions and up to six degrees for a non-symmetrical axial crush. It was also found that the engine may be operated to within approximately 2.7 feet of the lunar surface at minimum thrust and to within 2.4 feet at full thrust before nozzle flow separation occurs. Operation at low altitudes may result in engine skirt destruction due to shock formations. Critical heights may be decreased to 2.1 feet and 1.9 feet with a jettisonable skirt engine operating at an area ratio of 28.

A study was conducted to gain an approximate estimate of the effects of plume impingement on LEM landing gear and subsequent heating rates with a jettisonable nozzle skirt which has been discussed as a possible LEM modification. Preliminary results[23] indicate that such a modification would not create any serious problems.

Spacecraft Computers

Assistance to MSC in evaluation of the IBM back-up computer for the Apollo spacecraft continued. A report[24] was issued summarizing the evaluation of the computer design and the proposed production schedule. Evaluation of a closed-loop simulation of an AS-202 reentry will complete effort in this area.

Management Procedures In Computer Programming For Apollo

Schedules and status of Apollo software were monitored and monthly status summaries prepared.

Comment was provided on the draft documents covering configuration management of computer programming received from the Centers. Meetings were held with Air Force and MAP personnel to coordinate efforts in this area.

A draft report describing design and implementation practices for computer programming is under revision.

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(22) Effects of Fly-in and Nozzle Crushing on the Abort Capability of the LEM Descent Engine, Memorandum for File, J. A. Nutant, J. Wong, December 13, 1965.

(23) LEM Descent Engine Plume Impingement Study with Jettisonable Nozzle Skirt, Memorandum for File, R. Sehgal, December 30, 1965.

(24) Evaluation of the IBM Back-up Computer, TM-65-310-2, J. M. Nervik, November 12, 1965.

SCIENTIFIC STUDIES

Space Environment

Lunar Surface

Review of lunar surface data was continued with substantial emphasis on the interpretation of earth-based data. Brief studies on the possibility of hazard arising from the electrostatic levitation of lunar dust suggest that the possibility is small.

Radiation Environment

The review of solar cosmic ray events was completed.[25] Data on the time dependence, spectral slope, size and composition of the events of the last solar cycle peak were summarized. Empirical distribution functions for flare size and characteristic rigidity were developed and criticized in view of the uncertainty in data. It was concluded that every effort should be made to reduce the uncertainties in our knowledge during the next peak of solar activity.

In addition, a substantial effort has been expended in revising and updating capabilities for estimating radiation dose in the trapped radiation belts. Belt data, dose calculations, and computer program details have been examined. It is intended that improved calculations be made for both translunar injection and earth-orbital cases. Additional effort involved study of the proposed warning criteria for the Solar Proton Alert Network, and participation in studies of radioactive sources on the Apollo spacecraft.

Meteoroid Environment

A revised meteoroid model has been developed. A substantial review of photographic meteor data has been initiated, with the aim of further improving the meteoroid model, particularly with regard to the velocity distribution.

Site Survey

Surveyor Requirements

Investigation of the Surveyor TV equipment and data handling techniques has been continued to provide information on the scope and form of data for Apollo site selection. Recent redirection of the Surveyor program has reduced the range measuring and topographic mapping capability of Surveyor missions prior to Apollo by

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(25) Solar Cosmic Ray Events, TR-65-340-1, R. H. Hilberg, November 1, 1965.

eliminating one of the two stereo television cameras. A single camera focus-ranging technique has been analyzed and the results indicate that useful range information may be obtained in this manner.(26)

Work continued during this quarter on a Surveyor landing aid for Apollo. Functional specifications were written.

Surveyor targeting work has been accelerated by the introduction of a computer program which determines the available sites for each of the possible launch dates.

A study was initiated to examine the capability of engineering Surveyors to land at targets remote from the vertical impact point and therefore outside the currently specified region of accessibility.

A study was initiated to determine the desirability of providing a Surveyor Critical Data Recorder (CDR). Preliminary recommendations support the implementation of a CDR based essentially on a design submitted by JPL. The CDR could provide tactile data for Apollo in the event that Surveyor reaches the lunar surface but fails to return any information itself.

Lunar Orbiter Requirements

Studies associated with the Lunar Orbiter program in the areas of targeting and mission planning, photographic subsystem calibration, and orbit determination for selenodetic purposes are continuing.

Contingency Plans for Tactile Site Survey

A study has been conducted of plans for obtaining tactile data in the event of failure or schedule slip of the Surveyor program. Use of the Apollo Program, unmanned programs, and modifications of the Surveyor program were considered.

Trajectory studies have been performed concerning the deployment of probes from a spacecraft in lunar orbit(27) and from the LEM near the surface.

Evaluation of tactile data from a variety of sensors, including those carried by engineering and operational Surveyors, was started. A set of soil models characterized by their response characteristics was generated to aid in this evaluation.

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(26) Measuring Range from Surveyor Camera Focus Settings, Memorandum for File, P. L. Chandeysson, September 16, 1965.

(27) Out-of-Plane Launches of Probes from an Apollo Spacecraft in Lunar Orbit, TM-65-1012-11, V. Hamza, December 15, 1965.

Lunar Data

Plans have been formulated for computer processing of Lunar Orbiter data at MSC[28]. A description of the Lunar Orbiter format has been prepared[29] and interface plans on Lunar Orbiter tape recordings have been proposed.[30]. A survey of the technology of photographic data processing has been conducted.

Site Survey Data Analysis

Implementation of plans for analysis of Lunar Orbiter and Surveyor data at MSC has proceeded. The evolving program has been summarized in a draft program plan, which is being reviewed by MSF and MSC.

Lighting Considerations

The astronaut's view of the lunar surface has been simulated by a series of pictures taken of a lunar surface model for different lighting constraints and landing approaches. Each picture has been identified on the photometric function chart that is currently being used in the Apollo Program.[31]

Apollo Experiments

Items reviewed briefly in this quarter include the Apollo airlock, interference with experiments by radioactive sources on the spacecraft, the possible contamination of lunar surface samples by the LEM descent exhaust, and the reporting of experiment development milestones.

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(28) Trip Report - Conference on Lunar Orbiter Photographic Data Processing at MSC, Memorandum for File, C. S. Sherrerd, December 13, 1965.

(29) The Lunar Orbiter Photographic Data Channel, TM-65-1012-9, F. S. Flatow, November 1, 1965.

(30) Trip Report - Discussion of Lunar Orbiter Data Processing at LRC, Memorandum for File, F. S. Flatow, December 15, 1965.

(31) Lighting and Approach Angle Considerations for Manned Lunar Landings, TM-65-1012-13, V. Hamza, H. W. Radin, December 7, 1965.

SPECIAL TASK ENGINEERING STUDIES

ASSISTANCE IN CERTAIN COMPUTER OPERATIONS AND RELATED ACTIVITIES

TASK ORDER NO. 12

During the period of October 1, 1965 through December 31, 1965 NASA usage of the 7044 computer was 8.16 hours, Independent usage (non-BCMSYS) of the 7040 computer was 3.25 hours by the Department of Agriculture and 3.70 hours for General Service Administration.

PLANNING OF SYSTEMS OPERATIONS AND EXPLORATION TASKS - FIRST PHASE MANNED LUNAR EXPLORATION (Apollo Applications Program Studies)

TASK ORDER NO. 18

Draft revisions to the Flight Mission Assignment Plan (FMAP) for the Apollo Applications Program (AAP) have been produced.

Other work in connection with mission planning included a study of the relative merits of the LEM Lab and MOL for AAP missions and preparation of a draft of the technical section for the forthcoming Program Development Plan.

Tentative experiment assignments to six early AAP missions[32],[33] were made in support of the FMAP and mission planning studies being conducted by the Apollo Applications Mission Planning Task Force. Effort is continuing to maintain cognizance of the experiments in the Apollo Applications Program as it evolves.

A study was conducted[34] to obtain estimates of the data load generated by AAP missions based on tentative experiment assignments. These estimates were made in connection with MSF planning for possible augmentation of the Apollo Manned Space Flight Network (MSFN) for the AAP missions.

An interim report[35] on space rescue capability in the AAP program was presented to MSF. The report examines requirements for space rescue and suggests a number of rescue related development study tasks suitable for inclusion in the AAP program.

Two trajectory studies for AAP missions were completed this quarter. The first was concerned with the ΔV requirements using a two impulse transfer maneuver from translunar flight to a lunar parking orbit[36]. The second dealt with the effects

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(32) Experiment Assignment to Four AA Flights, Phase I, Memorandum for File, T. C. Tweedie, September 30, 1965.

(33) Experiment Assignments for Two AA Phase I Missions, Memorandum for File, T. C. Tweedie, October 20, 1965.

(34) Data Generation by AAP Experiments, Memorandum for File, D. Basson, December 20, 1965.

(35) Plan for Development of Space Rescue Capability in AAP Interim Report (U), Memorandum for File, G. B. Troussoff, December 14, 1965, CONFIDENTIAL.

(36) A Method for Computing Characteristic Velocities in an Orbital Transfer Maneuver and its Application to the Establishment of a Lunar Parking Orbit, TM-65-1013-3, R. Y. Pei, December 7, 1965.

of an S-IVB stage restart capability for earth synchronous missions[37]. Work is continuing on various trajectory problems associated with AAP missions.

A review was made of NASA plans for manned simulation of long duration flights to support AAP and more advanced missions[38].

Study effort has begun to determine the extent and feasibility of modifications to Apollo spacecraft systems necessary to support the experiments on AAP missions[39].

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(37) Two Aspects of the Earth's Synchronous Mission as Affected by the S-IVB Stage Restart Capability, TM-65-1013-4, R. Y. Pei, December 14, 1965.

(38) NASA Plans for Manned Simulation of Long-Duration Flights, Memorandum for File, T. A. Bottomley, B. H. Crane, H. A. Watson, October 27, 1965.

(39) AAP Alternate Mission Thermal Control Considerations, Memorandum for File, W. W. Hough, December 13, 1965.

MSF CENTER COMPUTER OPERATIONS STANDARDIZATION

TASK ORDER NO. 25

The results and recommendations of the first phase of this task have been reported[40][41]. A presentation of these recommendations was made to the MSF Resource Sharing Panel on December 2, 1965[42]. The panel approved recommendations for telemetry data standards, an abstract standard, documentation requirements, and endorsed the concept of a central librarian for program sharing.

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(40) Resource Sharing in MSF - Initial Report, Memorandum for File, B. H. Liebowitz, W. H. Wattenburg, C. H. Byrne, (CSC), December 21, 1965.

(41) The Single Document Approach to Computer Program Documentation, TM-65-1031-4, W. M. Keese, W. H. Wattenburg, December 22, 1965.

(42) Trip Report - Resource Sharing Panel, MSC, December 2, 1965, Memorandum for File, B. H. Liebowitz, December 8, 1965.

SATURN IB/CENTAUR SYSTEMS ENGINEERING

TASK ORDER NO. 26

This task was terminated on October 15, 1965, and the final report[43] was distributed in November. During the period a survey of the Voyager Program contamination requirements was completed and distributed[44]. A draft of "Saturn IB/Centaur Program Description", October 22, 1965, was delivered in late October.

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(43) Saturn IB/Centaur Systems Engineering Final Technical Report, TR-65-226-1, P. L. Havenstein, November 8, 1965.

(44) Survey of the Impact of Voyager Contamination Requirements on Launch Vehicle, Memorandum for File, T. H. Crowe, October 19, 1965.

GENERAL MISSION ENGINEERING STUDIES

GENERAL MISSION ENGINEERING STUDIES

Manned Space Flight Experiments Program

A survey of the programs of scientific, technological, and engineering investigation proposed for the Apollo Applications Program is under way. The objectives of the task are to define and review the status of these programs and to assist in the definition of requirements for support of experiments.

Drafts of an experiments catalog together with a computerized index have been prepared and delivered to the Advanced Manned Missions Program Office and to the Saturn/Apollo Applications Program Office. In final form the catalog will contain descriptions of all proposed and approved experiments in uniform format.

A review was made of the feasibility of orbiting a giant* mirror around the earth(45). It was shown that the mirror would reflect 2.8 million kilowatts of thermal power from the sun. Delivery of the energy to a small area on the earth's surface would be impracticable except for a synchronous orbit at about 22,000 miles. At this distance the image would be too large to be useful except for illumination. A possible application for this or smaller mirrors lies in power production for nearby space stations, where the system may yield an order of magnitude more watts per pound than large solar cell arrays.

Advanced Manned Mission Studies

Based on Mariner IV probe data which indicated lower Martian surface pressure than previously assumed, a study(46) was conducted to evaluate the effects on the design of Martian entry systems. It was found that use of "conventional" entry techniques may not be feasible since this would necessitate the attainment of extremely low W/C_DA values for the entry vehicle. At values of W/C_DA which can reasonably be obtained with parachutes, either considerable shock attenuation or terminal retro-rockets must be employed to reduce substantially the terminal velocity of the vehicle. Several possible configurations which may alleviate this problem were presented.

A study(47) was conducted to investigate possible magnitudes of pressure non-uniformity around Mars and location of maximum pressure areas. Preliminary results indicate that the atmospheric density at the poles may be 2 to 4 times that of the equator.

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* One mile in diameter.

(45) Giant Orbiting Mirror, Memorandum for File, F. G. Allen, November 16, 1965.

(46) Fundamentals of Entry into the Martian Atmosphere, Memorandum for File, H. S. London, T. R. Kornreich, J. M. Tschirgi, October 4, 1965.

(47) Magnitudes of Pressure Non-uniformity Around Mars, Memorandum for File, J. A. Nutant, December 22, 1965.

An investigation[48] was conducted to compare the performance characteristics of rocket braking and passive impact attenuation landing systems for the terminal phase of Martian landing. It was found that passive impact systems require payloads capable of surviving 1000 - 2000g and terminal descent velocities below approximately 500 fps. For the higher terminal velocities (over 100 fps), the rocket braking system provides a performance advantage over the passive system.

A preliminary examination was made of the launch complex requirements necessary to accommodate a proposed Saturn IB/Zero stage.[49]

A parametric study is in progress to investigate the heat shield weight requirements for typical Mars entry vehicles. A computer program is being developed to determine the appropriate heat distribution over the surface of a family of spherically capped conical bodies. These distributions are based on the stagnation point heat flux and account for both convective and radiative heat transfer mechanisms. In addition, straight-line closed-form total heating coefficients are being generated which provide a relationship between the important parameters affecting the total heat load and heat protection weights.

Preliminary results of a study of nuclear versus chemical propulsion for manned Mars landing missions for the 1978-1986 period have been discussed with MSF. The study compares the gross weights required in earth orbit for nuclear and chemically propelled spacecraft. The data obtained to date are preliminary due to the assumptions made and options considered. They are intended initially to determine the significant parameters rather than to justify the assumptions. The preliminary results, however, confirm that the weight-in-orbit required for nuclear stages is approximately 50 to 70 percent of that required for all-chemical stages.

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(48) Comparison of Rocket and Passive Impact Attenuation Landing System for Terminal Phase of Martian Landing, Memorandum for File, D. Macchia, November 2, 1965.

(49) Launch Complex for Saturn IB/Zero Stage, TM-65-2032-3, H. E. Stephens, October 15, 1965.

ENGINEERING SUPPORT

Computing Facility

A new loading scheme for processors was introduced into the Bellcomm Monitoring System (BCMSYS) in October. An appreciable saving in loading time has been realized which is reflected in the utilization of the 7040/7044. Other new capabilities were introduced including the facility for programmers to maintain their jobs on the disk on a day-to-day basis.

The need for acquisition of a new bulk storage device was strongly indicated by increased programmer utilization of the disk. It is planned to install an IBM 2302 replacing the IBM 1301 as soon as possible. Operating system modifications in anticipation of the IBM 2302 were initiated.

The applications programming staff members assisted various Bellcomm groups in areas such as:

(1) Targeting and Trajectory Studies

(2) Lunar Reconnaissance Trajectory Study

(3) Guidance and Navigation System Performance Evaluation

(4) General Purpose Data Storage and Retrieval System

(5) Apollo Communications System Capability.

(6) LEM Auto Pilot Simulation

(7) Lunar Landing Site Selection

(8) Tracking Coverage Display

(9) Terrain Analysis for LEM Guidance

(10) Earth Radiation Belt Display

(11) Transfer Orbit Data Analysis

(12) Surveyor Landing Site Study

(13) Apollo Applications Program Description Documentation

The following is a list of major study areas for which programs were completed during this quarter:

(1) Stabilization of a Synchronous Satellite

(2) Meteoroid Means/Velocity Distributions

(3) Tracking Analysis

(4) Trajectory Computations for Lunar Orbiter

(5) Mission Payload Study

(6) Simulation of Flight Crew Activity

LIST OF REPORTS AND MEMORANDA

(Listed in Order of Report Date)

This index includes technical reports and memoranda issued during this period covering particular technical studies.

The memoranda were intended for internal use. Thus, they do not necessarily represent the considered judgment of Bellcomm which is reflected in the published Bellcomm Technical Reports.

TITLE	DATE
Project Apollo - Study of Carrier Interruption Effects on Phase Locked Loop Operation, MF5-4334-18 , J. C. Lumsden, Bell Telephone Laboratories, Inc.	September 16, 1965
Measuring Range from Surveyor Camera Focus Settings, Memorandum for File, P. L. Chandeysson	September 16, 1965
Apollo Mission Sequence Plan TR-65-214-1 , System Analysis Department	September 30, 1965
Experiment Assignment to Four AA Flights, Phase I Memorandum for File, T. C. Tweedie	September 30, 1965
Fundamentals of Entry into the Martian Atmosphere Memorandum for File, H. S. London, T. R. Kornseich, J. M. Tschirgi	October 4, 1965
Letter to A. Cohen (MSC) regarding AS-202 guidance equations in MIT Document R-477, W. G. Heffron	October 5, 1965
Letter to G. Hunt (MSC) regarding Internal Note 65-FM-109 on guidance error analysis, W. G. Heffron	October 11, 1965
Trip Report - Design Engineering Inspection for SC 011, Downey, California, August 30-September 2, 1965 Memorandum for File, T. A. Bottomley, P. R. Knaff, T. J. McEntee, V. Muller, J. J. O'Connor, P. F. Sennewald	October 12, 1965
Launch Complex for Saturn IB/Zero Stage TM-65-2032-3 H. E. Stephens	October 15, 1965
Trip Report - CM Access Arm Working Group Meeting Downey, California, October 12, 1965, Memorandum for File , P. R. Knaff, L. G. Miller	October 18, 1965

TITLE	DATE
Survey of the Impact of Voyager Contamination Requirements on the Launch Vehicle, Memorandum for File , T. H. Crowe	October 19, 1965
Experiment Assignments for Two AA Phase I Missions, Memorandum for File, T. C. Tweedie	October 20, 1965
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